VERA C. RUBIN OBSERVATORY

Processing Crowded Field images with the LSST Science Pipelines

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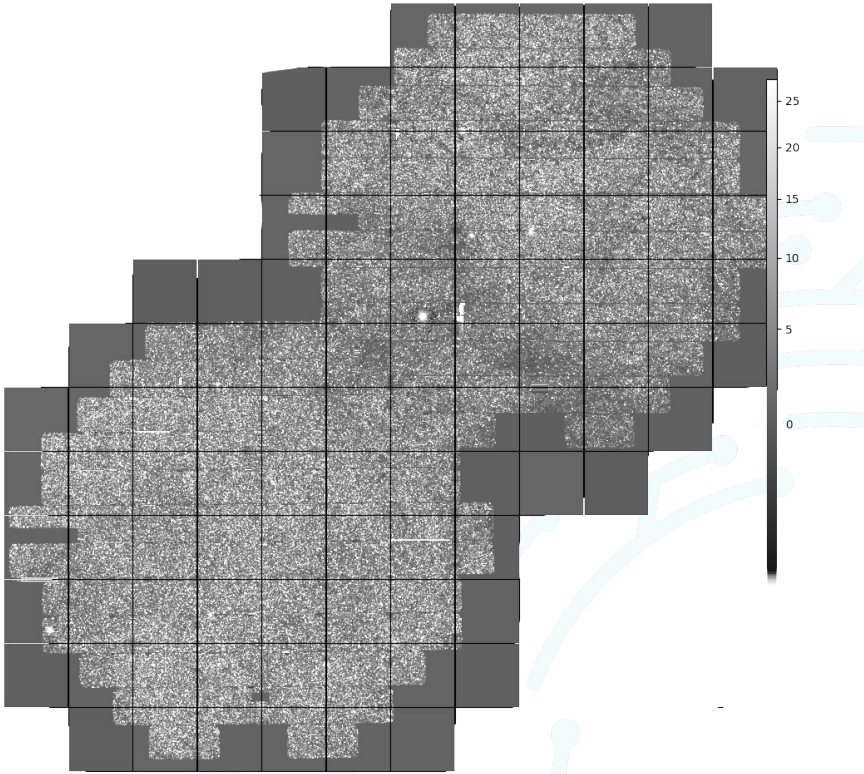
Saha Galactic Bulge reprocessing

- DECam Galactic Bulge Survey by Saha et. al processed in 2021 with v21.0 of the LSST Science Pipelines
- See https://dmtn-171.lsst.io for details
- Overlapping fields B1 and B2, in both g- and i-band
- Processed through the full Alert Production pipeline

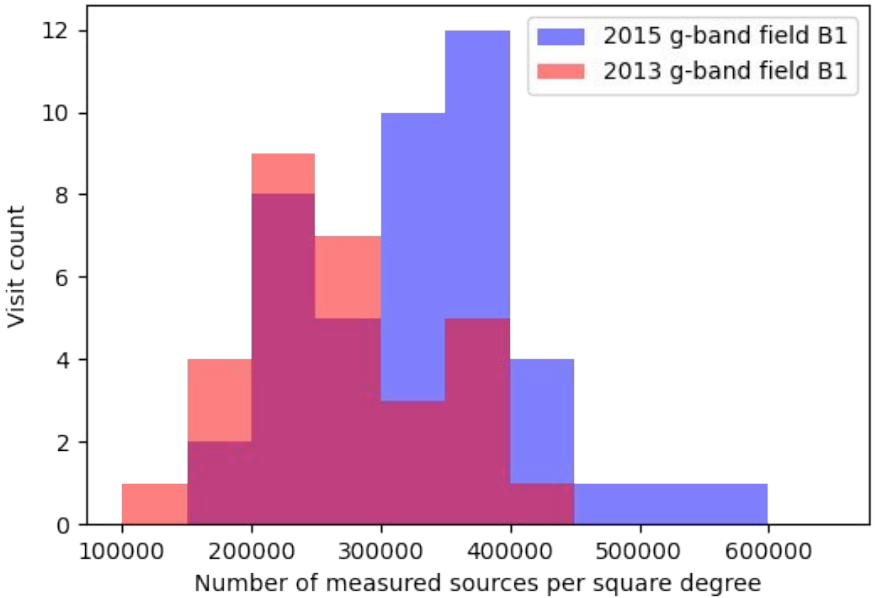


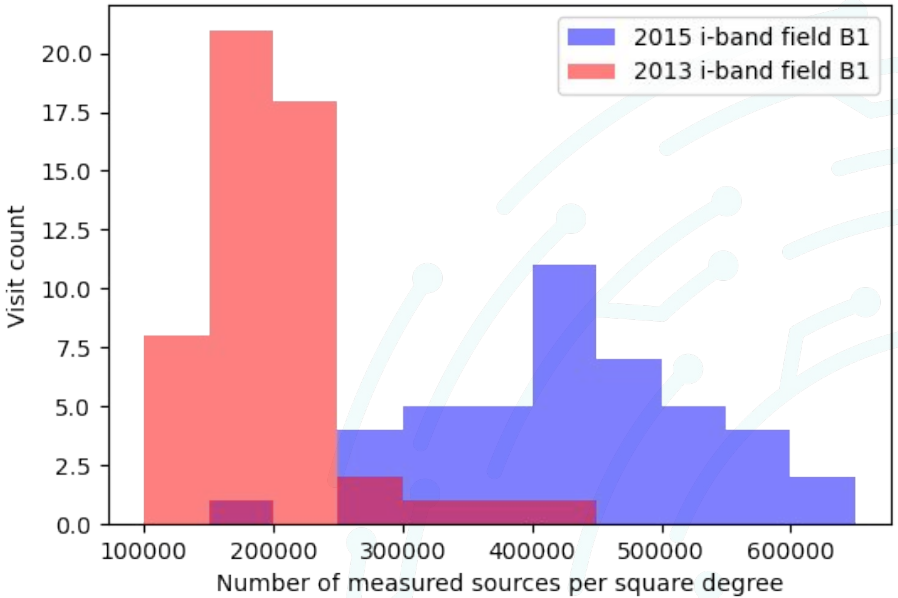
Crowded field config changes

Modified config settings for processCcd.py	value	band
charImage.requireCrForPsf	False	i, g
charImage.detection.thresholdValue	10000	i
charImage.detection.thresholdValue	2500	g
charImage.detection.includeThresholdMultiplier	1.0	i, g
charImage.detection.thresholdType	“value”	i, g
charImage.repair.cosmicray.nCrPixelMax	10000000	i, g
charImage.repair.cosmicray.min_DN	10000	i
charImage.repair.cosmicray.min_DN	2500	g

Past processing summary

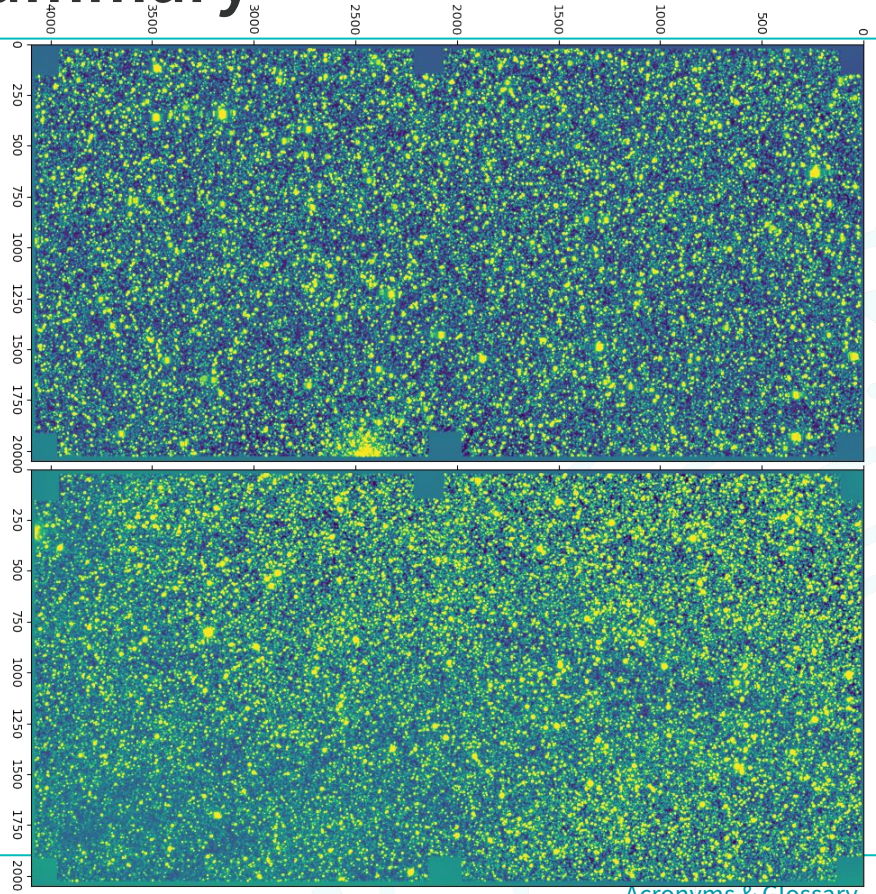
The LSST Science Pipelines can detect and measure in excess of 400,000 sources/degree^2





Past processing summary

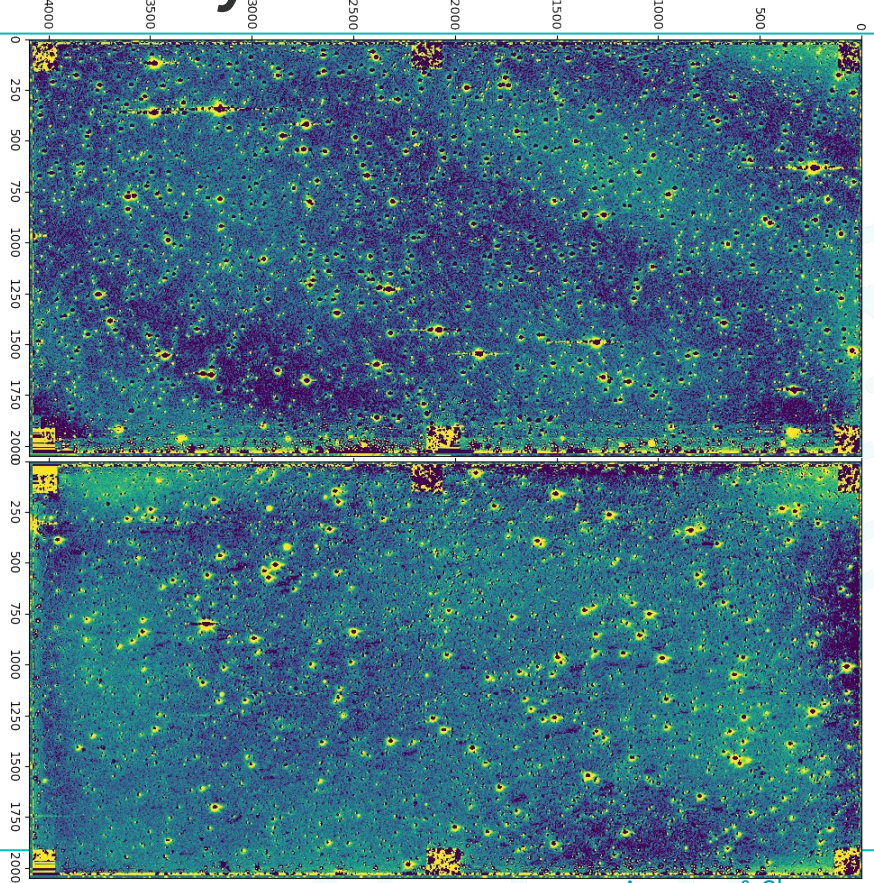
These fields are very dense, with no background pixels…



Acronyms & Glossary

Past processing summary

…but the image differences are still sparse



Recent status

- Reprocessing of the DECam Galactic Bulge dataset handed over to Erin Howard
- Full dataset successfully processed at USDF through calibration
- New challenges with image differencing and resource allocation
- Crowded fields require significantly more time and memory, which has been a challenge

Relevant pipeline changes

- New image differencing Task since the 2021 processing
  - Old implementation computed a corrected variance plane for the final image difference, new task computes the correction for the input science and template images
  - Variance scaling of the science image incorrect in crowded fields. Needs investigation, but ideally variance scaling would not be needed
- New Calibration Task coming soon
  - Should reduce the memory requirements for calibration, but needs testing

Prompt Processing

- Prompt Processing is the framework that will run the Alert Production pipeline
- The payload is configurable, and can run a modified AP pipeline for predefined regions
- Individual processes that exceed a configured timeout will be terminated.
    - Timeout is currently 10 minutes
    - A daytime catch-up service will process any images missed during the night

Future Work (direct images)

- At densities >200k/sq deg, simultaneous fitting of overlapping PSF sources (a.k.a. DAOPhot) will improve completeness, and above 500k/sq deg it is required for direct-image photometry.
- We have prototyped a simultaneous fitter that is integrated in the DM Science Pipelines, but it is only a proof-of-concept and it is still a long way from being a serious battle-tested code.
- An alternative strategy would be to integrate a code from the community into our existing python-C++ code base — this would also require significant work.
- Broadly interested in possible solutions along either of these two lines, but time before on-sky-commissioning is getting short and DM's focus will need to be on all-sky image differencing and basic image processing.